

# *Using VAMOSOC to Understand Operating and Support Costs*

*DoD Cost Analysis Symposium*

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# **Outline**

- ❖ Background
- ❖ Study Objective
- ❖ Study Ground Rules
- ❖ Key Concepts / Terms
- ❖ Database
- ❖ Estimating Relationships
- ❖ Summary
- ❖ Related DODCAS Presentations



## **Background** - *The Environment*

- ❖ DoD & DoN initiative to reduce Total Ownership Cost (TOC) are focused largely on Operating & Support (O&S)
- ❖ SECNAV policy of 16 Apr 98 endorses Cost as an Independent Variable (CAIV) as the process for reducing TOC of new and fielded weapon systems
  - 7 DoN CAIV tenets
  - Tenet #4 is ‘conduct cost versus performance trade-offs’
- ❖ ASN RDA policy of 5 May 98 requires all DoN ACAT I-IV programs to establish TOC reduction goals
  - ACAT I/II goals by Dec 98
  - ACAT III/IV goals by Jun 99



## **Background** - *The Problem*

- ❖ O&S cost cannot be reduced until they are understood
- ❖ DoN Science and Technology (S&T) and acquisition communities do not understand O&S costs
- ❖ Tools to facilitate understanding of O&S cost are in short supply
  - CAIV process requires tools that enable O&S cost versus performance trades



## **Objective**

- ❖ Conduct ground-breaking research that results in O&S cost estimating methodology for application:
  - by the S&T and acquisition communities
  - throughout the life cycle of a technology or system
- ❖ The methodology will be statistical Cost Estimating Relationships (CERs) that relate O&S cost to one or more performance, physical or programmatic parameters



## **Ground Rules**

- ❖ CERs should be compatible with structure/level of detail of US/UK Operating and Support Cost Analysis Model (OSCAM) for ship systems
- ❖ CER or set of CERs for each of the following:
  - Organizational/Intermediate (O/I) Level Maintenance
  - Organic Depot Maintenance
  - Contractor Depot Maintenance
  - Modernization
  - Engineer and Technical Services
  - Software Maintenance
  - Training
  - Manning



## **Ground Rules**

- ❖ Distinct CERs for each of the following:
  - Radars
  - Sonars
  - Fire Control Systems
  - Electronic Warfare Systems
  - Electronic Detection and Tracking Systems
- ❖ This briefing addresses O/I-Level Maintenance for radars only, which represents 11% of total O&S



## **Key Concepts / Terms**

### **Organizational Level Maintenance**

- ❖ Includes maintenance performed by ships force
- ❖ Modeled by type of action
  - Scheduled
  - Unscheduled
  - Alterations
- ❖ Includes the following components
  - Actions per year
  - Manhours per action
  - Repair parts per action
  - Cost per repair part
  - Repairables per action
  - Issue cost
  - Exchange cost



## **Key Concepts / Terms**

### **Organizational Level Maintenance**

- ❖ Repair parts - parts which do not have a repair philosophy, but instead have a discard philosophy
- ❖ Repairables - components having a repair philosophy; when removed they are usually sent to the depot to be repaired
- ❖ Issue Cost - Price charged if no carcass is turned in. Includes the cost to buy a new component, plus a surcharge which accounts for the cost of the supply system to manage the item
- ❖ Exchange Cost - Price charged if carcass is turned in. Includes the cost to repair the component, plus a surcharge which accounts for the cost of the supply system for managing the item and replenishing stock levels due to inability to repair some of the components



## **Key Concepts / Terms**

### **Intermediate Level Maintenance**

- ❖ Ashore - Cost of Shore Intermediate Maintenance Activities (SIMA) to perform repairs and alterations
- ❖ Afloat - Cost of tenders and repair ships to perform repair and alterations while the ship is at sea

# **Database** - *O&S Data (FY91 - 97)*

*3 Activity Types*

Organizational  
Intermediate Ashore  
Intermediate Afloat

*3 Action Types*

Unscheduled  
Scheduled  
Alterations

*3 activity types  
x 3 action types  
x 7 field types  
= 63 Fields*

*7 Data Field Types*

Actions per Ship per Year  
Manhours per Action  
Repair Parts per Action  
Cost per Repair Part  
Repairables per Action  
Issue Cost  
Exchange Cost



## **Database** - *Technical / Programmatic Data*

- ❖ Weight (lbs)
  - Antenna weight
  - Below deck weight
  - Total weight
- ❖ Frequency (Ghz) and Wavelength Band (X, C, S, L)
- ❖ Peak Power (KW)
- ❖ Gain (dB)
- ❖ Year of Initial Operating Capability (IOC)
- ❖ Procurement Cost (constant FY98\$ in 000's)



## **Database - Radar Population**

- ❖ 43 radars identified for analysis
- ❖ 27 radar systems were discarded due to inadequate data:
  - 3 radars had no identifiable equipment identification codes (necessary for O/I cost collection)
  - 5 radars had no O/I cost data associated with them
  - 19 radars had fewer than 25 total O/I actions each over a 7 year period
- ❖ 16 radars retained for analysis
  - Due to data limitations, not all 16 data points were applicable for every estimating relationship derived



## **Database** - *Radar Population*

❖ Final set of radar systems analyzed:

<u>1950's</u>	<u>1960's</u>	<u>1970's</u>	<u>1980's</u>
– SPS-10	– SPS-39	– SPS-58	– SPS-64
	– SPS-40	– SPS-55	– SPS-67
	– SPS-30	– SPS-48C	– SPS-66
	– BPS-15	– SPS-49	– SPS-48E
		– SPS-52	– SPS-65
		– SPS-59	

# **Estimating Relationship Overview**

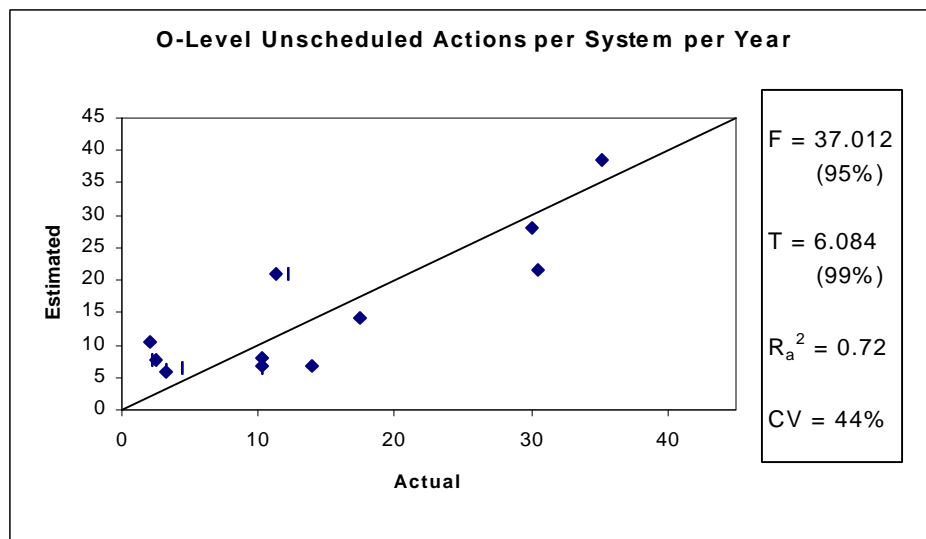
	O-Level			I-Level Ashore			I-Level Afloat		
	<i>Unscheduled</i>	<i>Scheduled</i>	<i>Alterations</i>	<i>Unscheduled</i>	<i>Scheduled</i>	<i>Alterations</i>	<i>Unscheduled</i>	<i>Scheduled</i>	<i>Alterations</i>
<b>Actions per System per Year</b>	√	√	√	√	√	√	√	√	√
<b>Manhours per Action</b>	√			√					
<b>Repair Parts per Action</b>	CER not developed *			√					
<b>Cost per Repair Part</b>	√			√					
<b>Repairables per Action</b>	√			√					
<b>Average Issue Cost</b>	√			√					
<b>Average Exchange Cost</b>	√			√					
<b>Repair Parts per Repairable</b>	√			CER not developed *					

\* Repair parts per repairable = (Repair Parts/Action) ÷ (Repairables / Action)

# ***CER for Actions***

- ❖ System size (weight) influences O-Level Unscheduled Actions
  - Represents ~ 95 percent of total actions
  - Other types of actions vary significantly due to differences in maintenance philosophy

Antenna Weight  $\xrightarrow{+}$  OUA



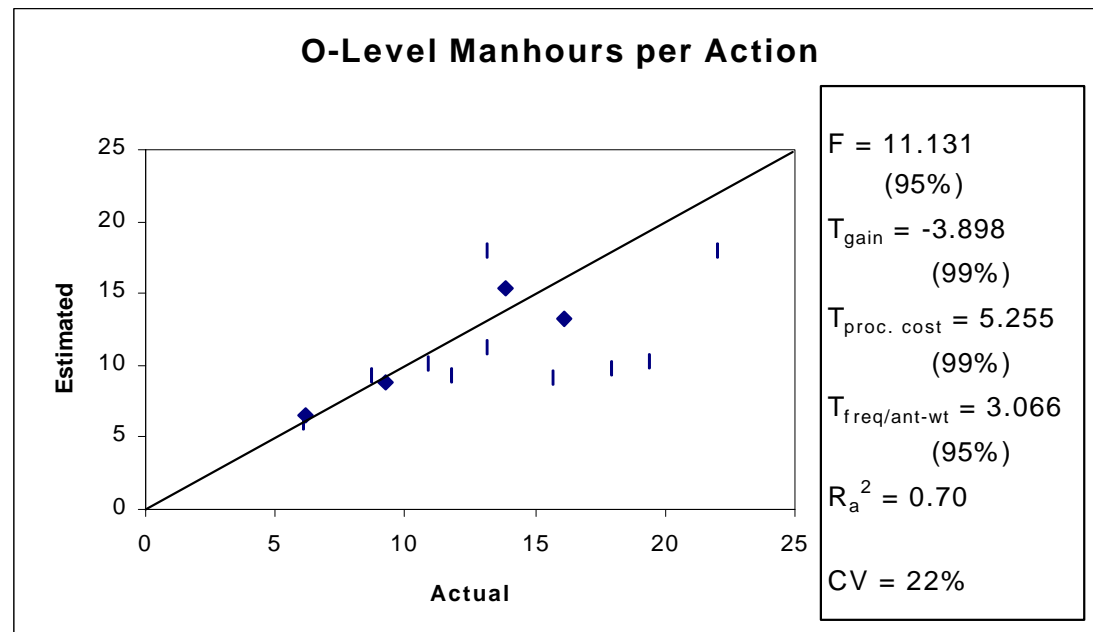
+

OSA  
 OAA  
 IasUA  
 IasSA  
 IasAA  
 IafUA  
 IafSA  
 IafAA

# **CER for O-Level Manhours per Action**

Freq / Ant-Wt.

Proc. Cost  $\xrightarrow{+}$  O-Level MHRS/Action  $\xleftarrow{-}$  Gain

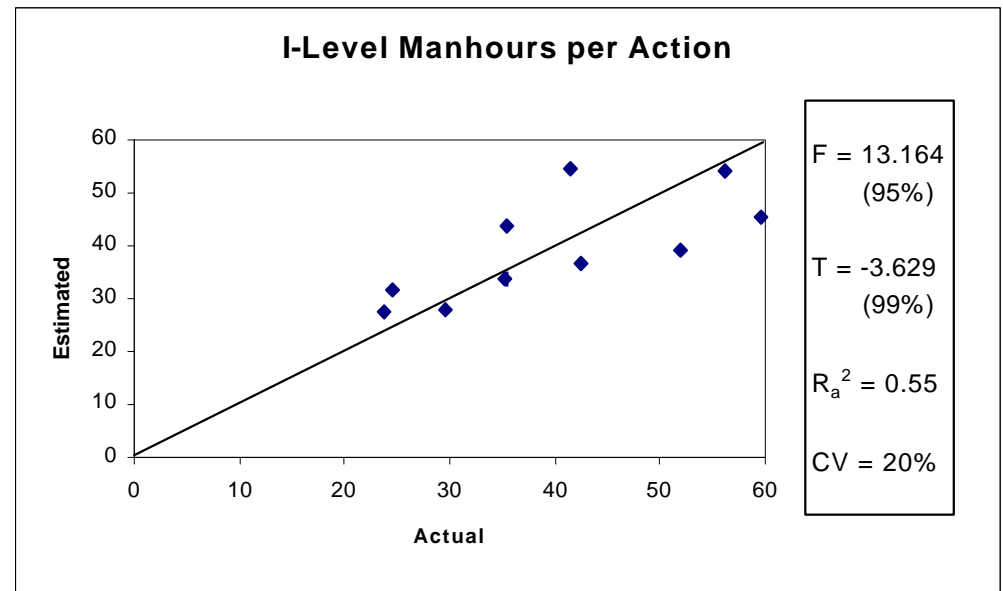


- ❖ Procurement cost and Freq/Ant-lb represent factors of complexity and indicate that more complex systems require more manhours per action.

## **CER for I-Level Manhours per Action**

O-Level MHRS/Action  $\longrightarrow$  I-Level MHRS/Action

- ❖ The model shows that as O-level manhours per action decrease, I-Level manhours per action increase.
- ❖ Complexity of the action at the activity level is influenced by the design and maintenance philosophy of the system.





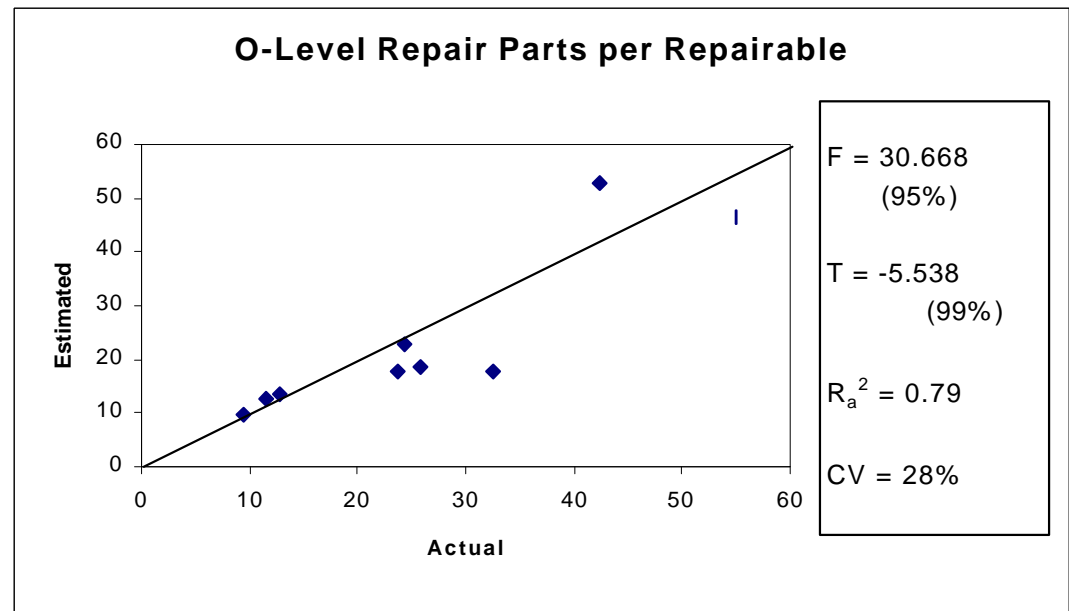
# **Methodology for Repair Parts per Action**

- ❖ O-Level
  - Derived by using Repair Parts per Repairable and Repairables per action
- ❖ I-Level
  - Data indicated no direct relationship with any of the other parameters. Modeled by using the weighted average.

# **CER for O-Level Repair Parts per Repairable**

IOC  $\xrightarrow{\quad}$  O-Level Repair Parts/Repairable

- ❖ The data examined spans 3 decades and indicates that the number of repair parts / repairable has consistently decreased by approximately 1/3 every 10 years.
- ❖ The model indicates that we should expect the next generation of radars to have 3-5 repair parts / repairable.





# **Methodology for Cost per Repair Part**

## ❖ O-Level

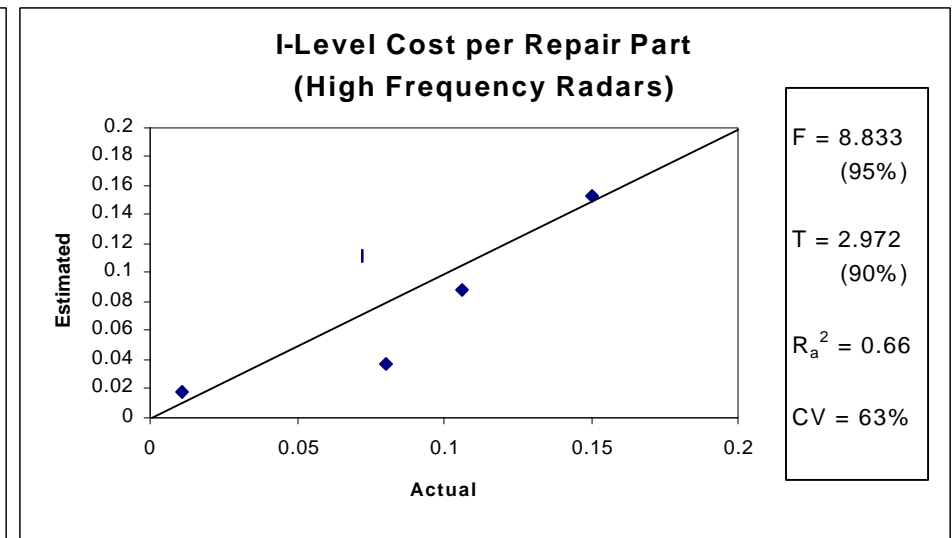
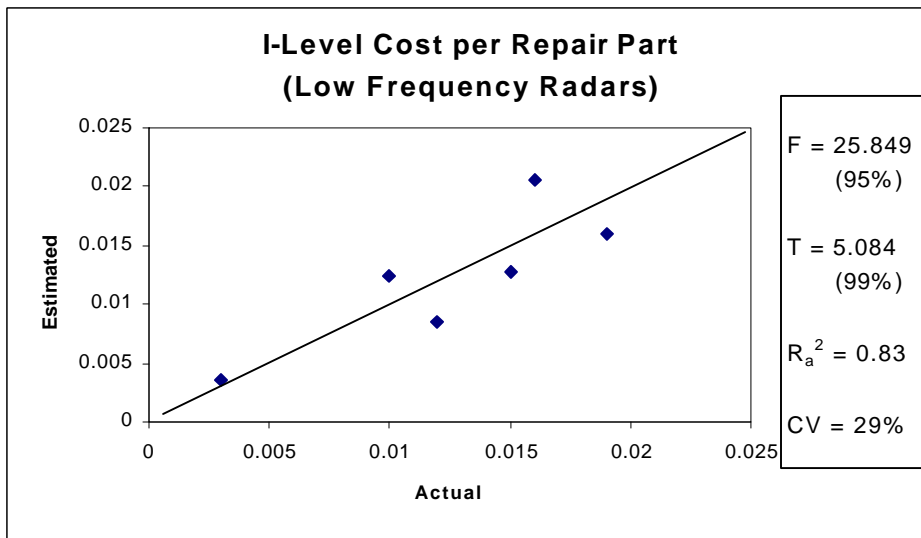
- Data indicated no direct relationship with any of the other parameters. Modeled by using the weighted average.

## ❖ I-Level

- Two CERs were developed:
  - ♦ Data analysis revealed that there is a difference in cost per repair part between high frequency radars (X-band) and low frequency radars (L, S, and C bands)

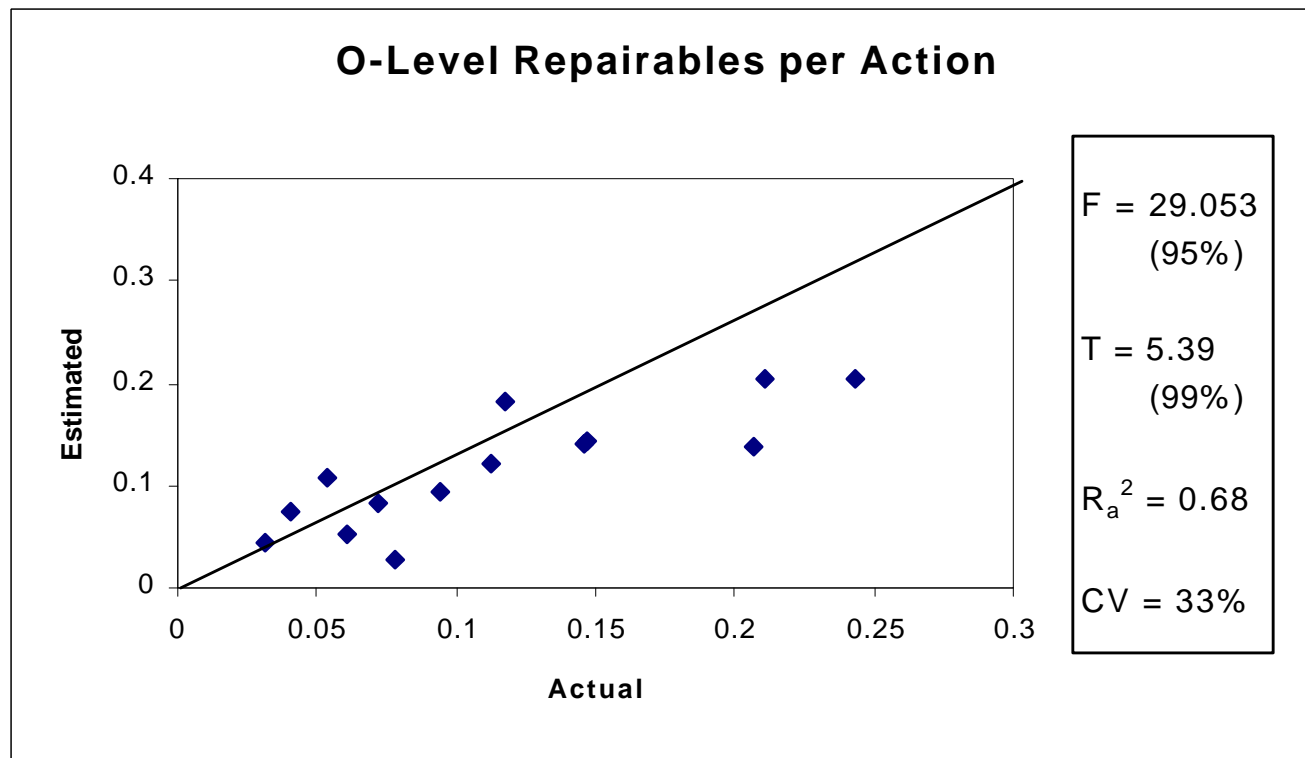
# ***CERs for Cost per Repair Part***

Antenna Weight by wavelength band  $\xrightarrow{+}$  I-Level Cost per Repair Part



# ***CER for O-Level Repairables per Action***

Power  $\xrightarrow{+}$  O-Level Repairables per Action



- ❖ The model indicates that repairables per action vary as a function of peak radar power.

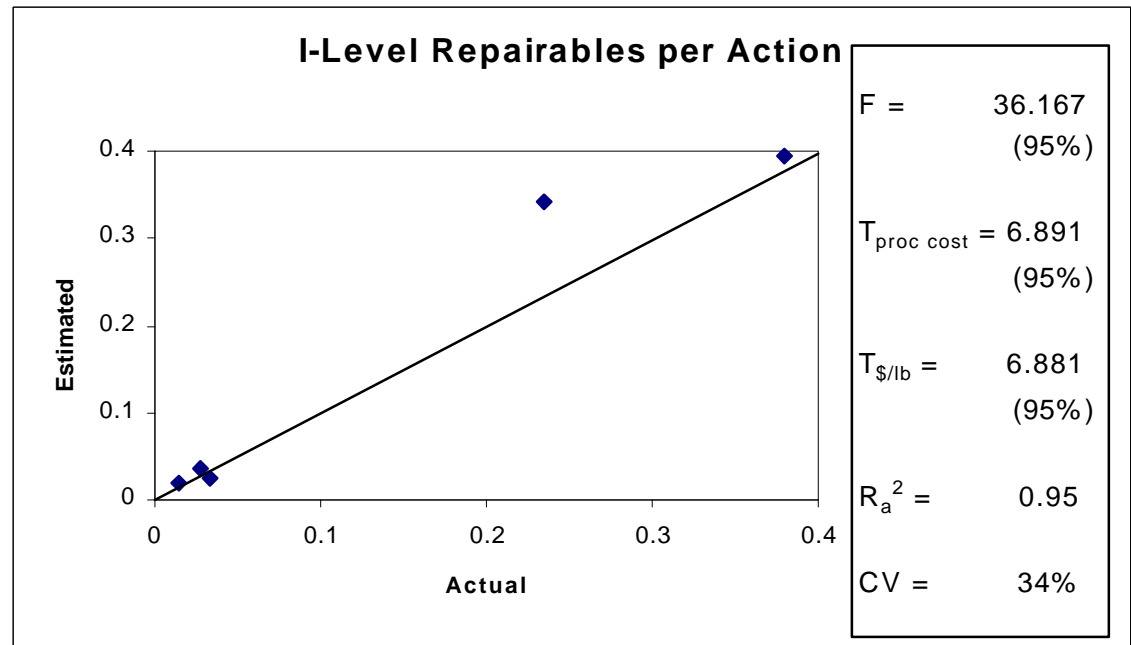
# ***CER for I-Level Repairables per Action***

Procurement Cost

Procurement Cost / Weight

$\swarrow + \quad \nwarrow +$   
I-Level Repairables per Action

- ❖ Procurement cost and \$/lb represent factors of size and complexity, therefore the model indicates that bigger, more complex systems require more manhours per action.



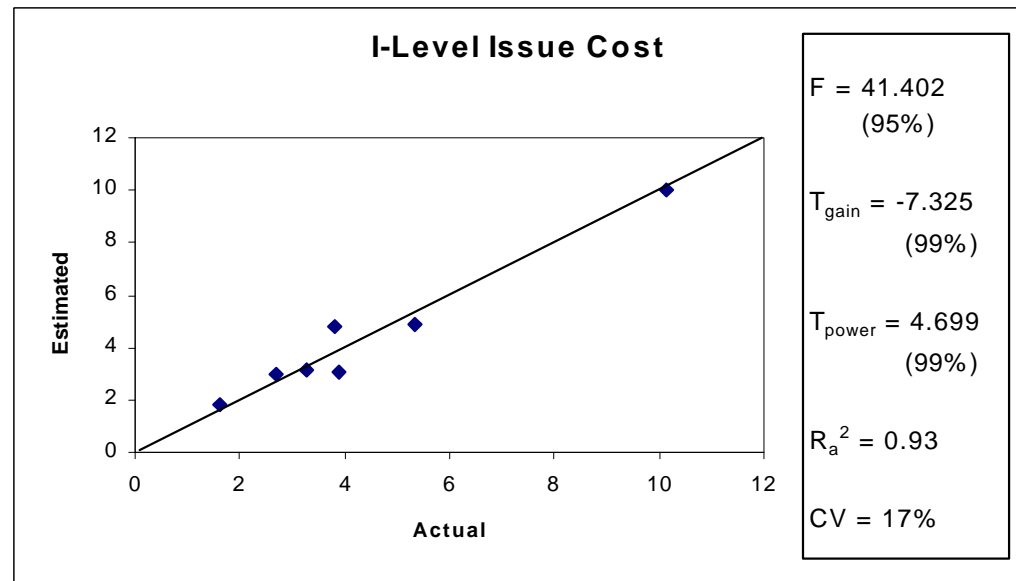
# **CER for Average Issue Cost**

## ❖ O-Level

- Data indicated no direct relationship with any of the other parameters. Modeled by using the weighted average.

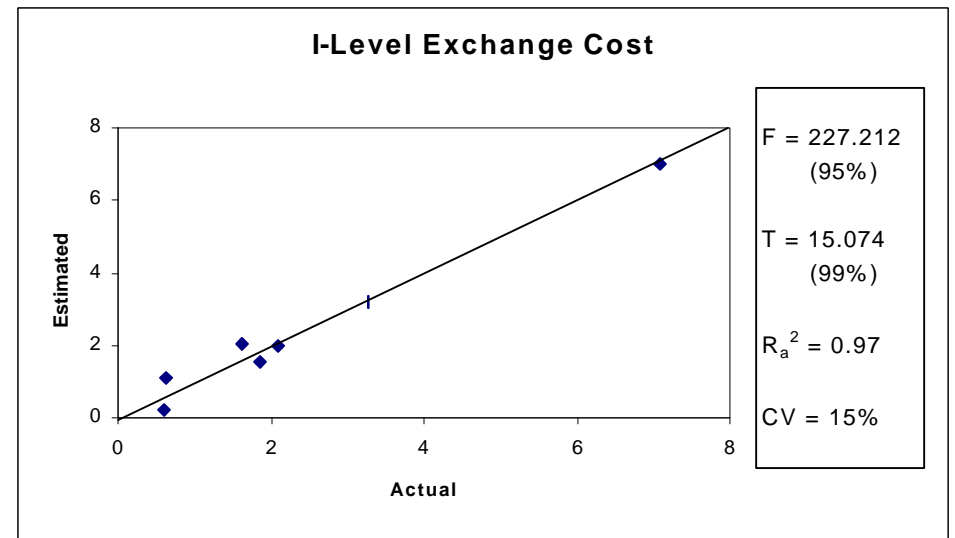
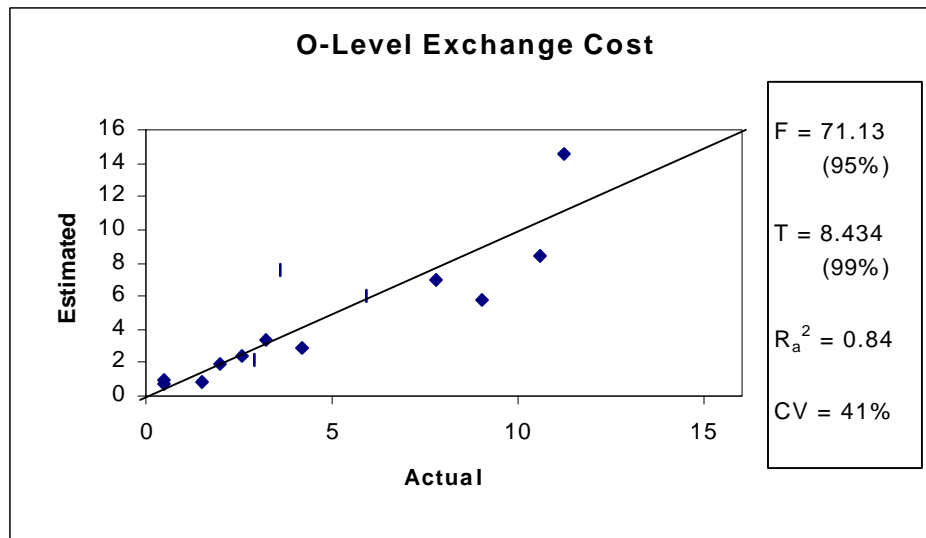
## ❖ I-Level

- Model indicates average issue cost is a function of gain (which is proportional to antenna size) and peak power.



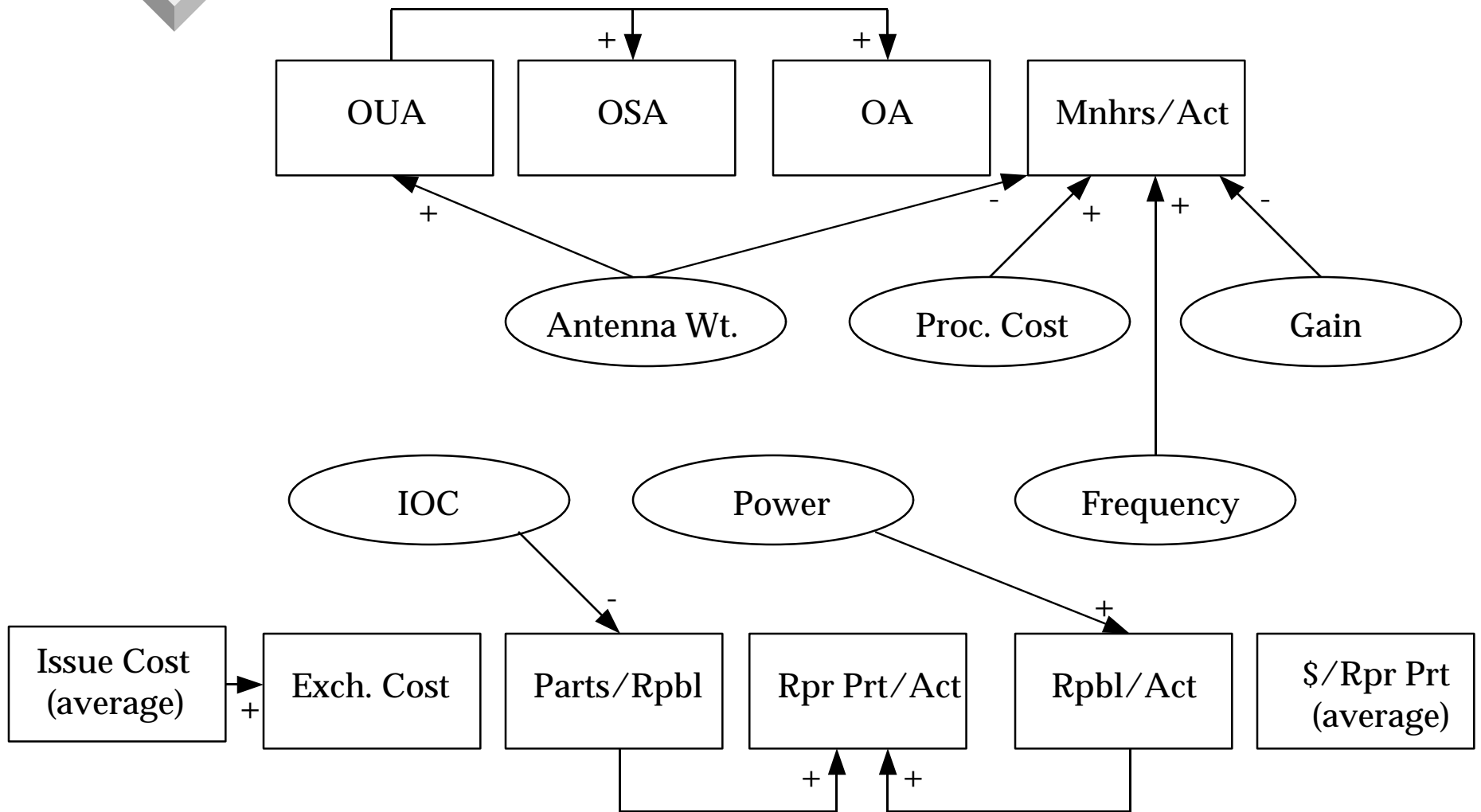
# **CER for Average Exchange Cost**

Average Issue Cost  $\xrightarrow{+}$  Average Exchange Cost

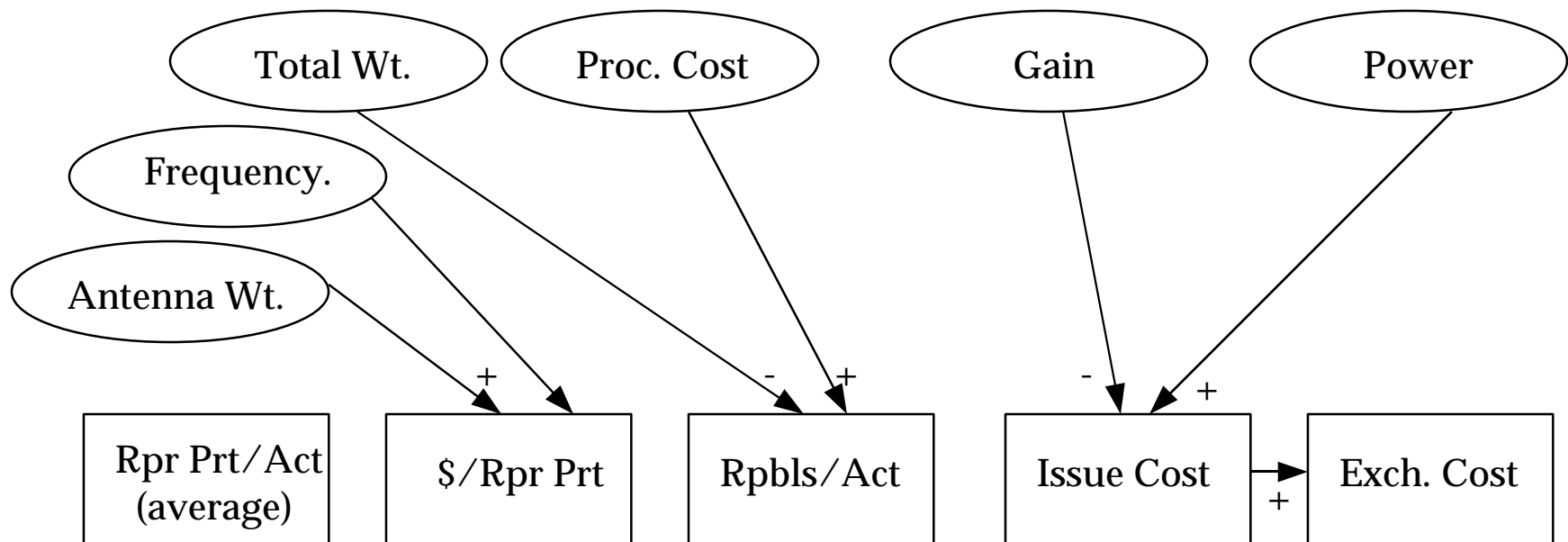
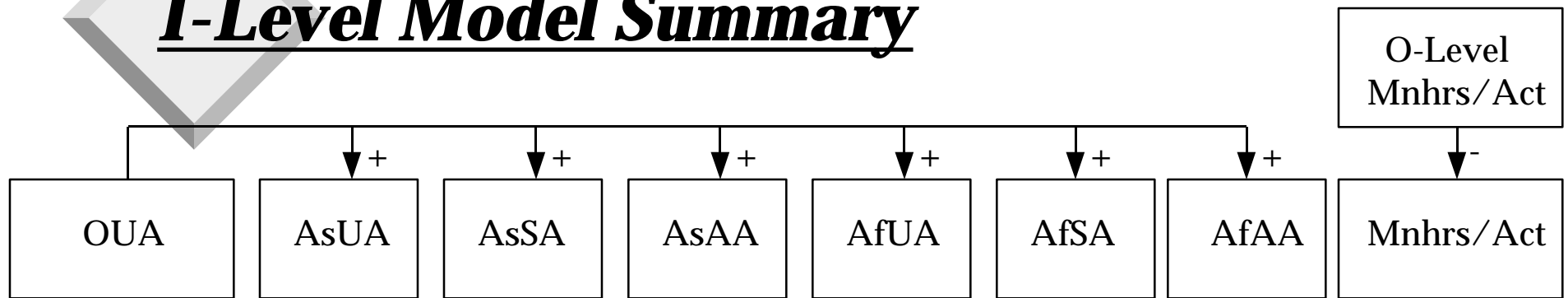


❖ Exchange cost was found to be directly influenced by Issue Cost

# ***O-Level Model Summary***



# ***I-Level Model Summary***





## **Summary**

- ❖ The VAMOS database is a useful source of data from which parametric estimating relationships can be derived
- ❖ These relationships should facilitate our understanding of O&S cost
- ❖ NCCA/Tecolote effort will continue
  - CERs for the other O&S cost elements
  - CERs for other ship electronics (i.e. sonar, fire control, etc.)
  - CERs for commodity specific subsystems (i.e. radar transmitters)
  - CERs for generic subsystems (i.e. transmitters)



## **Related DODCAS presentations**

❖ *‘An Introduction to VAMOSC’*

Presenter: Ms Krystyna Kolesar (OSD/PA&E)  
Time: Today (1545 - 1700)

❖ *‘OSCAM for Ships and Ship Systems’*

Presenter: Mr. Paul Hardin (NCCA)  
Time: Tomorrow (1345 - 1500)